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(54) Improvements in circuit boards

(57) A circuit board is formed by depositing a liquid, e.g. molten, conductor in recesses formed in at least one face of base, the pattern of recesses corresponding to the required arrangement of conductors, followed by solidifying the liquid conductor to provide the required arrangement of conductors. Since the surface of the resulting board is substantially flat it preferably has laminated to it, a sheet of insulating material which will strengthen the board, improve the electrical resistance between adjacent conductors and give protection to the surface.

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FIG. 1.

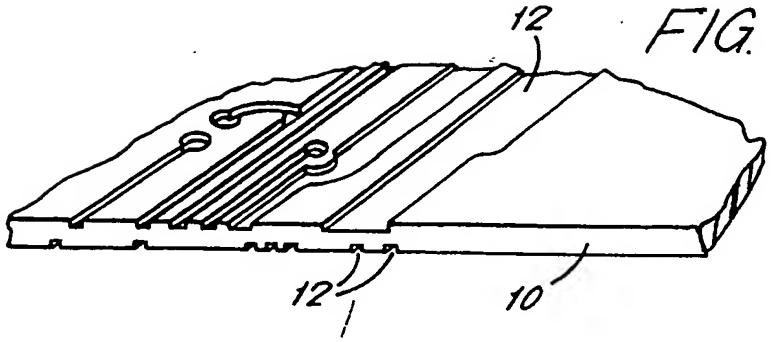


FIG. 2.

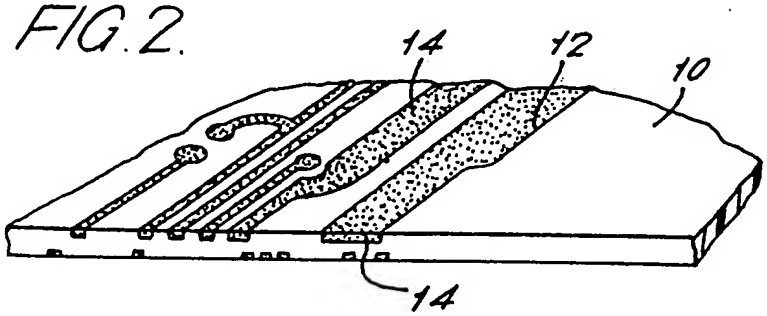


FIG. 3.

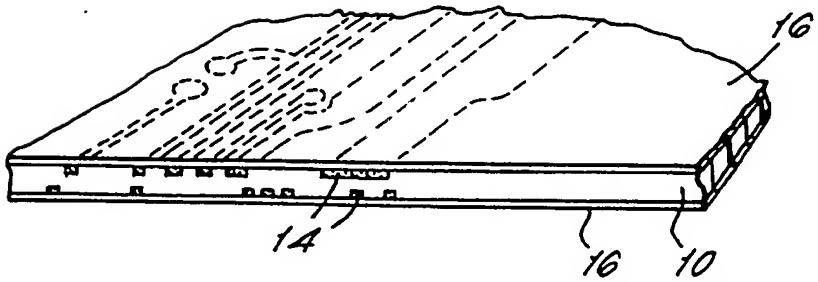
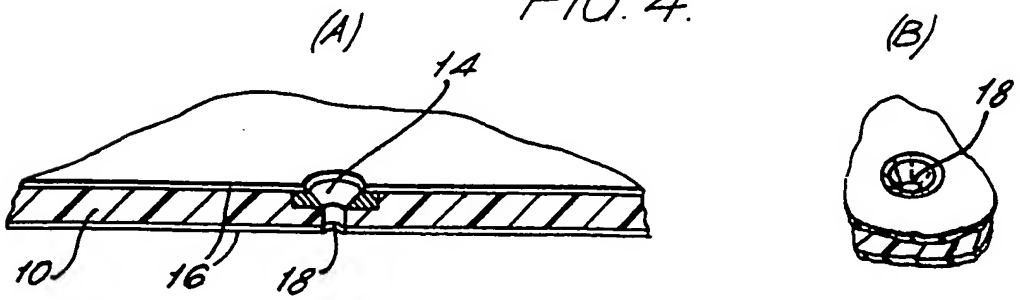


FIG. 4.



SPECIFICATION

Improvements in circuit boards

This invention relates to improvements in circuit boards.

Conventional circuit boards are prepared by coating a base layer, e.g. of fibre glass, with a thin copper layer on one or both of its faces, and then the copper layer is covered with a resist medium is discreet regions. Thereafter, when the board is etched in a copper dissolving liquid, the exposed regions of the copper layer are removed to leave conducting metal regions of the shape and arrangement required. The resist may be photographic resist layer which is coated uniformly over the copper and exposed to a light image corresponding to the pattern of copper strips required and after development the areas of the resist are removed image-wise to expose the copper. Alternatively, a discreet resist pattern may be silk-screen printed, e.g. by silk-screen printing, onto the copper layer.

Circuit boards produced in this way have been successful in practice but the resulting conducting copper strips are quite thin and liable to crack if the board is flexed and in addition a large number of steps is required in the preparation of such boards.

It is therefore an object of this invention to provide circuit boards where these disadvantages are overcome or at least mitigated.

According to the invention, there is provided a method of making a circuit board in which conductive material in a liquid state is deposited in a pattern of recesses corresponding to the desired arrangement of conductors formed in at least one face of a base so as to fill those recesses, and thereafter the conductive material is solidified so providing the required arrangement of conductors.

With such a circuit board the conductive material layers can be relatively thick as compared with the thin surface layers of conventional boards. Therefore, the risk of cracking the conductors can be much reduced. In addition, although there may be an increased cost of conductive material since a larger amount may be used, the process according to the invention involves fewer steps and a considerable saving in resist and etching chemicals. Accordingly the overall cost of such boards may be cheaper than conventional boards.

The conductive material preferably has a relatively low melting temperature so that it can be applied as a molten material and then allowed to cool and solidify *in situ* in the recesses of the base. This is not essential, however, and instead the conductive material could be a solution or dispersion in a volatile solvent, the solvent being allowed to evaporate away to leave solid conductive material after the solution or dispersion has been filled into the recesses in the base layer.

A preferred conductive material is a metal such as copper because of its high conductivity but other metals and alloys such as solder and other relatively low melting point alloys can be used.

The material of the base needs to be chosen depending upon the nautre of the conductive material and the way in which it is filled into the recess. Thus, if the conductive material is a metal which is melted and then poured into the recesses in the molten state, the base has to be capable of withstanding the temperature of the molten metal. On the other hand, this would not be a requirement if the conductive material were applied as a solution. Examples of suitable base materials are fibreglass and other fibre reinforced composite materials, ceramic materials and plastics materials.

The recess in the face of the base can be formed in many ways. For example the base can be moulded or cast so as to give the desired pattern of recess in its surface. Alternatively the required pattern of recess can be impressed or embossed into the face. As is conventional with conventional circuit boards, a pattern of recess may be provided in one or both faces of the base so that an electronic circuit can be formed adjacent one or both surfaces of the board.

In order to provide some protection for the pattern of conductors, it is desirable to cover the regions of these with locally applied insulating material. Accordingly in a circuit board according to the invention, the conductive material strips are covered with insulating material such as, for example, an insulating varnish, in a manner analogous to conventional printed circuit boards.

However, in a circuit board according to the invention, the conductive material can be flush with the top face of the base. Therefore it is preferred according to another aspect of the invention that the surface of the base be covered with a continuous insulating sheet and in the case where the board is double-sided, the base will therefore be sandwiched between two insulating layers. It is also advantageous to provide such insulating layers over one or both surfaces of a conventional printed circuit board. So according to a further aspect of the invention, there is provided a circuit board comprising an insulating base on which has been formed a pattern of discreet areas of conductive material and laminated to one or both faces is a continuous sheet of insulating material such as a synthetic polymer.

In this way I find that the continuous insulating sheet reduces the chance of solder shorts arising during construction of electronic circuits with the board and gives better insulation between the various conducting regions and the various components not connected to those regions. Furthermore the presence of this continuous insulating sheet adhered to the surface of the board gives increased dimensional stability and particularly in the case where an insulating sheet is provided over each surface of the base, the rigidity of the resulting board can be significantly increased.

Examples of suitable material for the insulating sheet are synthetic polymers, e.g. of polyvinyl chloride, polyvinylidene chloride, polyethylene or polypropylene and such sheets can, for example, be

of a thickness of from 0.10mm to 0.50mm.

Because one or both surfaces of the circuit board have the overall insulating sheet, it is possible to laminate two or more such boards face to face so providing a composite circuit board carrying more than two patterns of discreet conductive areas.

The invention will now be illustrated, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a base layer formed with surface indentations;

Figure 2 is a similar view of the circuit board with the indentations filled with conductive material;

Figure 3 is a similar view of the completed circuit board;

Figure 4A is a section through the completed board showing a hole for the attachment of an electronic component; and

Figure 4B is a detailed perspective view showing the hole.

The base layer 10 shown in Figure 1 has formed in both of its faces, a pattern of indentations 12. The pattern of indentations has been formed by moulding the material of the base layer and the precise pattern is chosen in accordance with the requirements of the electronic circuit of which the circuit board is to form part and the arrangement of such patterns is entirely conventional and is not believed to require further description.

Molten copper or the liquid conducting material is poured into the indentations 12 so as to fill them and is allowed to set *in situ*. The resulting circuit board is shown in Figure 2 and has discreet copper conductors 14 filling the indentations 12.

If necessary at this stage, the surface of the conductors 14 is scraped or otherwise planed down so that they are substantially flush with the face of the base layer 10. As shown in Figure 2 the copper conductors are thick as compared with the relatively thin surface coated areas of a conventional circuit board.

Preferably the resulting circuit board is sandwiched between two insulating sheets 16 of, for example, synthetic plastics material. These sheets 16 can be laminated to the surface of the circuit board in conventional manner.

As with conventional circuit boards, the board is next drilled with holes 18 through which the connecting wires of electronic components are positioned and soldered in place to the copper conductors 14. According to a preferred feature of the present invention these holes 18 have a frusto-conical shape so that they are enlarged in the region of copper conductor 14 so providing cone-shaped pockets in which solder can collect during the construction of the circuit to give strong mechanical and good electrical joins between the copper conductors 14 and the circuit elements.

CLAIMS

1. A method of making a circuit board in which conductive material in a liquid state is deposited in a pattern of recesses corresponding to the desired arrangement of conductors formed in at least one face of a base so as to fill those recesses, and thereafter the conductive material is solidified so providing the required arrangement of conductors.

2. A method as claimed in Claim 1 in which the conductive material is molten when deposited in the recess and solidifies *in situ* in the recesses upon cooling.

3. A method as claimed in either preceding claim in which the conductive material is copper.

4. A method as claimed in any preceding claim in which the pattern of recess has been moulded, cast, impressed or embossed into the face or faces of the base.

5. A method as claimed in any preceding claim in which a continuous insulating sheet is laminated to one or both faces of the base.

6. A method of making a circuit board substantially as herein described with reference to Figures 1 and 2 of the accompanying drawings.

7. A circuit board which has been made by a method as claimed in any preceding claim.

8. A circuit board comprising an insulating base on which has been formed a pattern of discreet areas of conductive material and laminated to one or both faces is a continuous sheet of insulating material.

9. A circuit board as claimed in Claim 8 in which the insulating sheet is of polyvinly chloride, polyvinylidene chloride, polyethylene or polypropylene.

10. A method as claimed in Claim 8 or 9 in which the or each insulating sheet has a thickness of from 0.10m to 0.50mm.

11. A circuit board substantially as herein described with reference to Figure 3 of the accompanying drawings.

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